



Geomorphology Techniques for Volunteers, Part 1: Concepts

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Delaware River Basin Commission

NJ Volunteer Monitoring Summit

November 7, 2003

A River Is a Machine

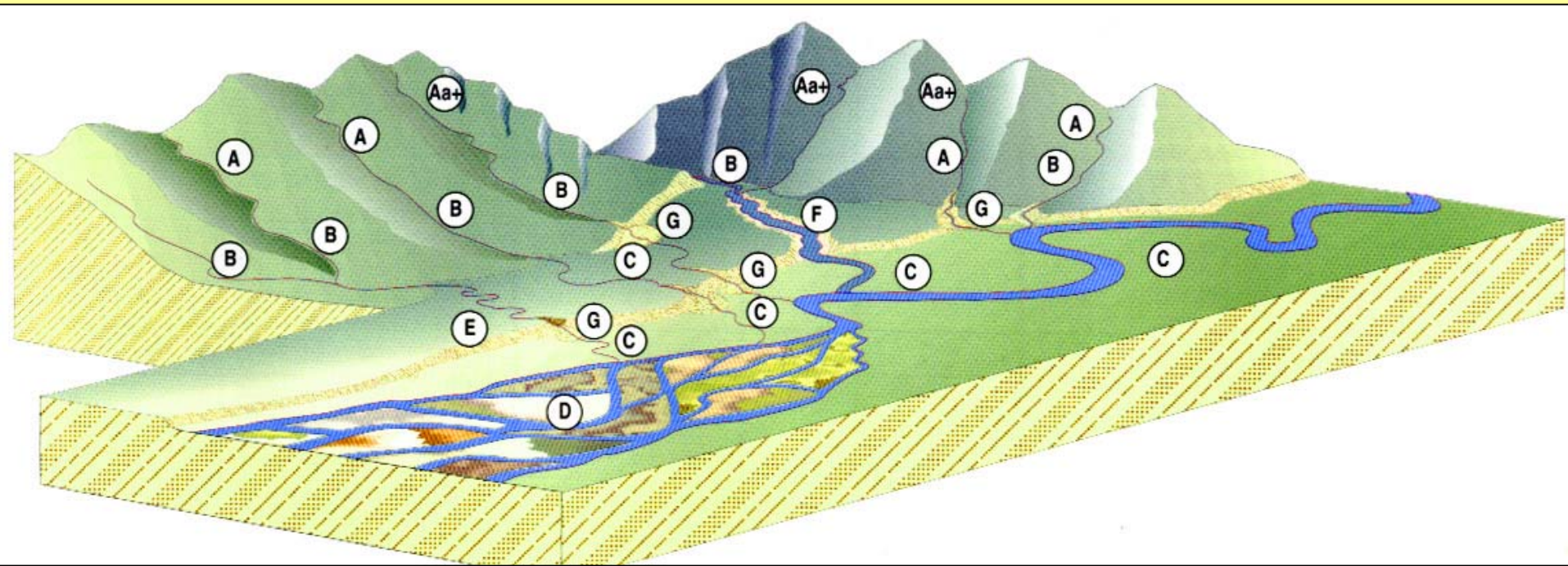
It transforms potential energy into kinetic energy to accomplish work.

Concept from *View of the River* (Leopold, 1994)

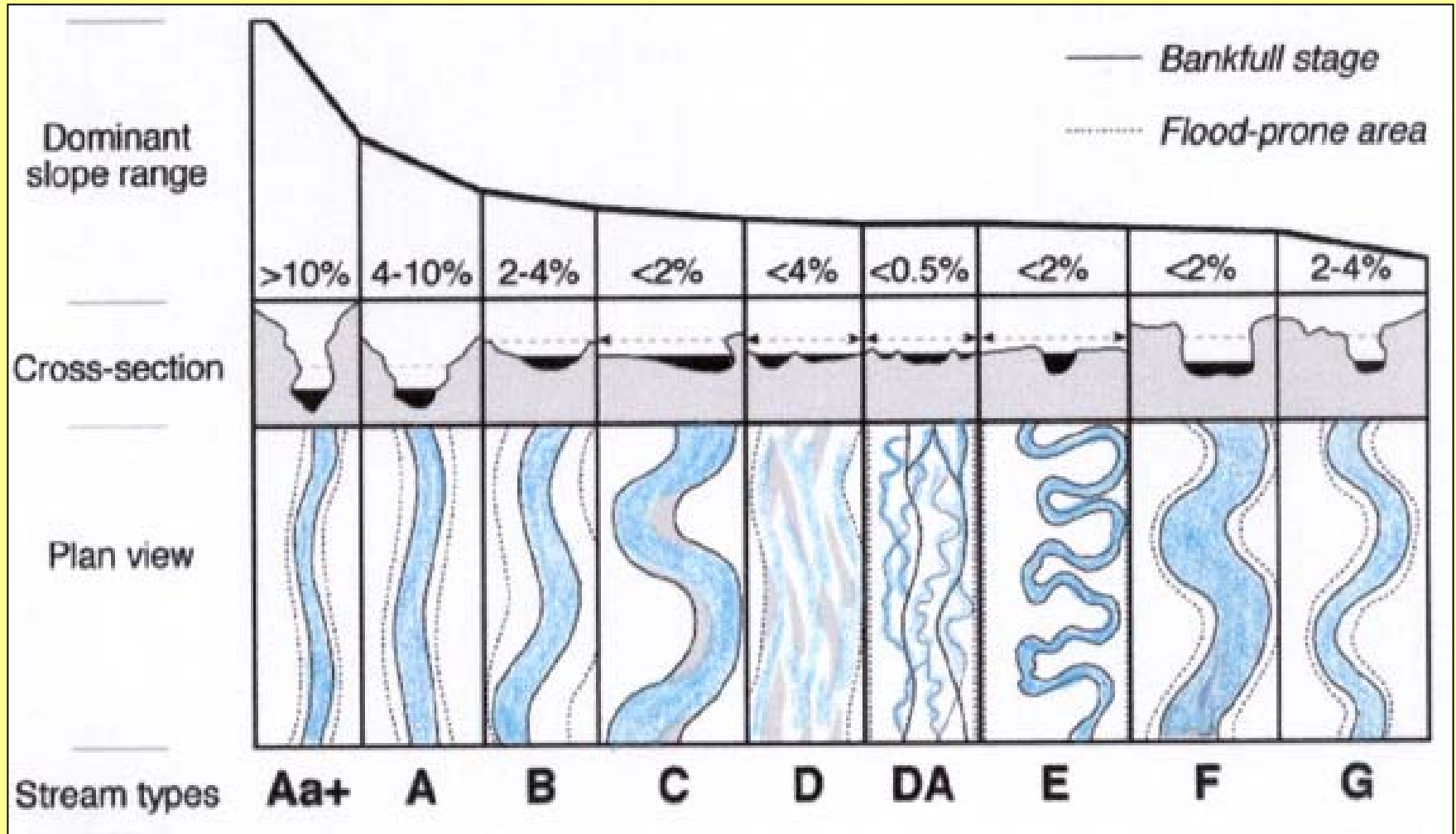
Where Does Stream Energy Come From?

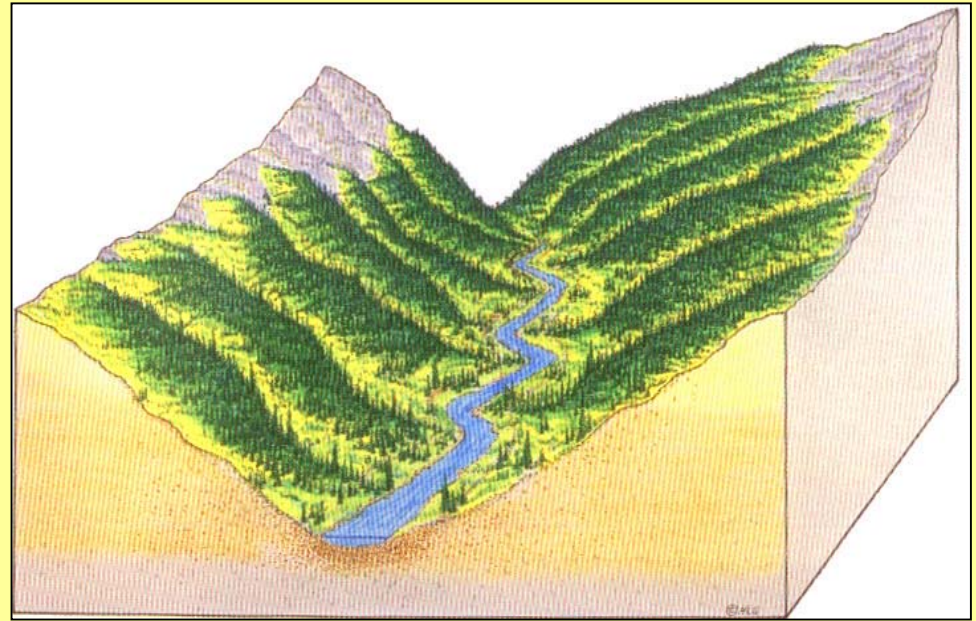
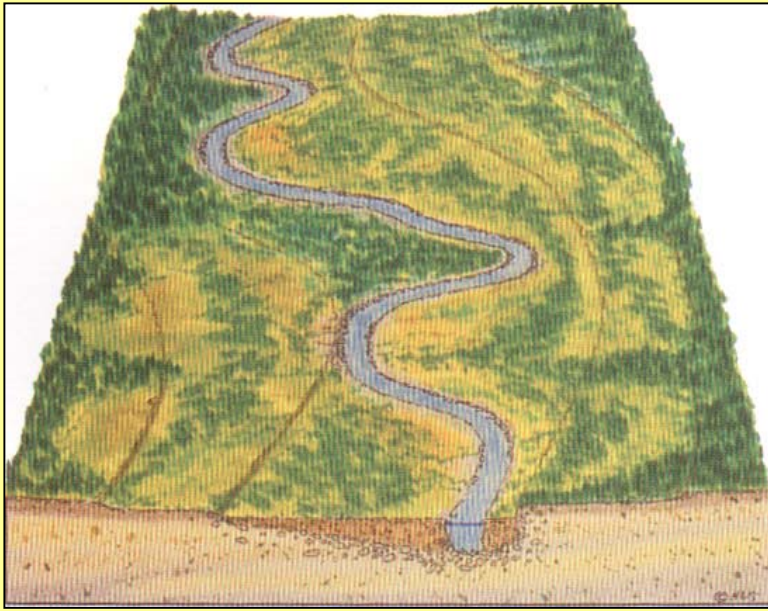
Specific Energy = Mean Depth
+ (Mean Velocity²/2g) where
g = acceleration due to gravity

Gravity Is a Function of Slope

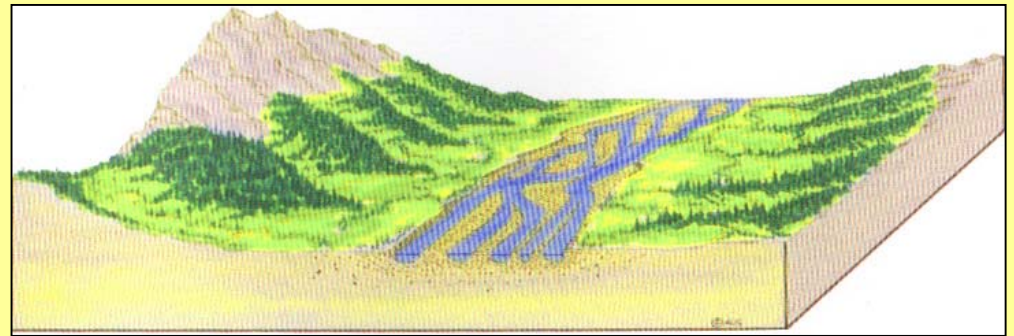


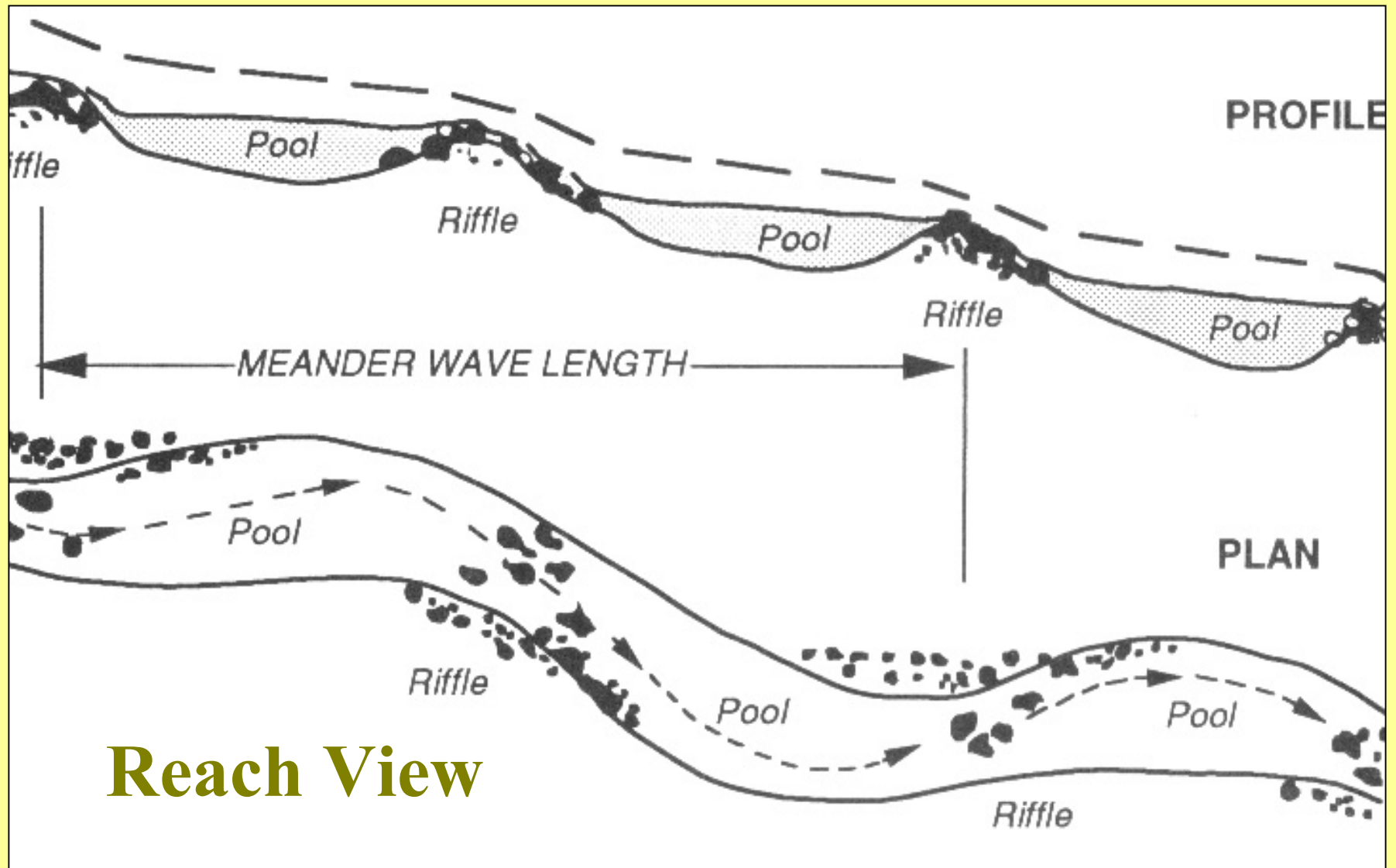
Rosgen Stream Classification System



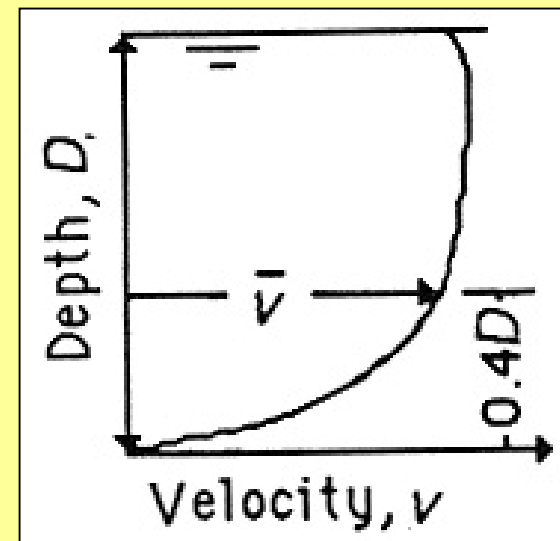
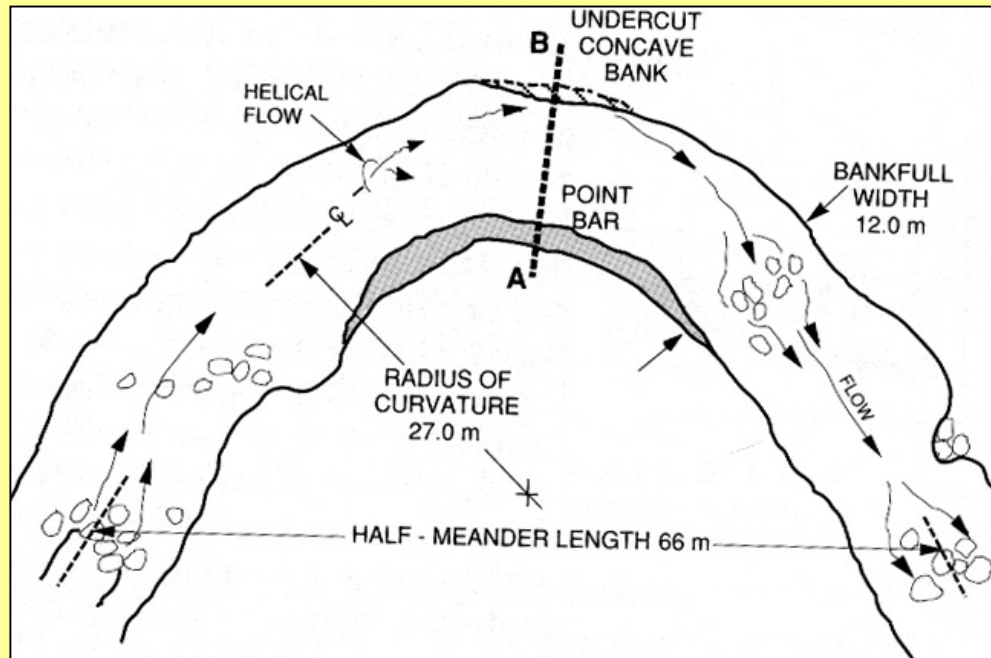
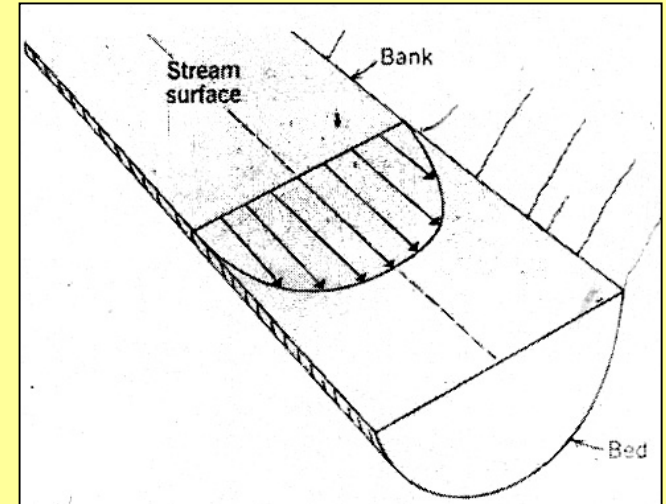
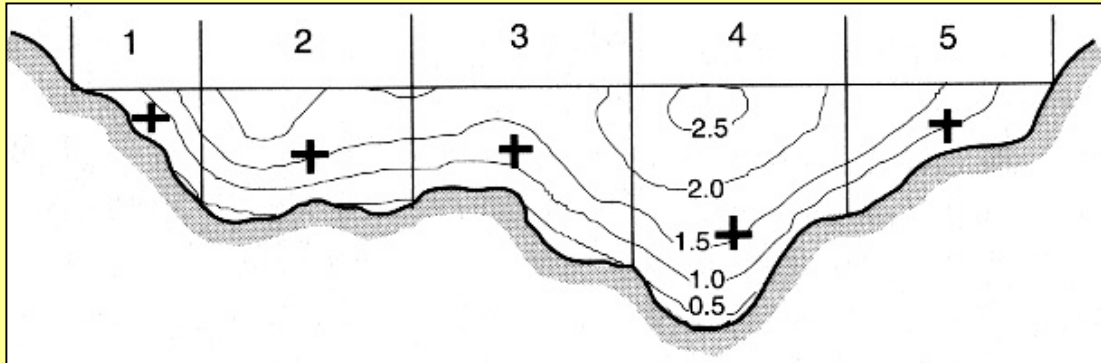


**Watershed View:
The Valley Shape
Determines the
Stream Type.**

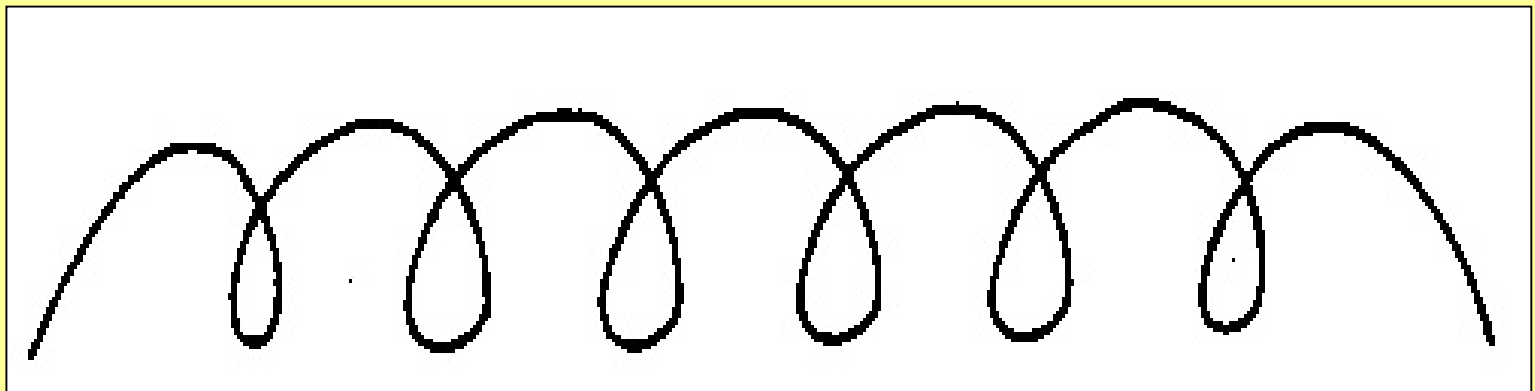
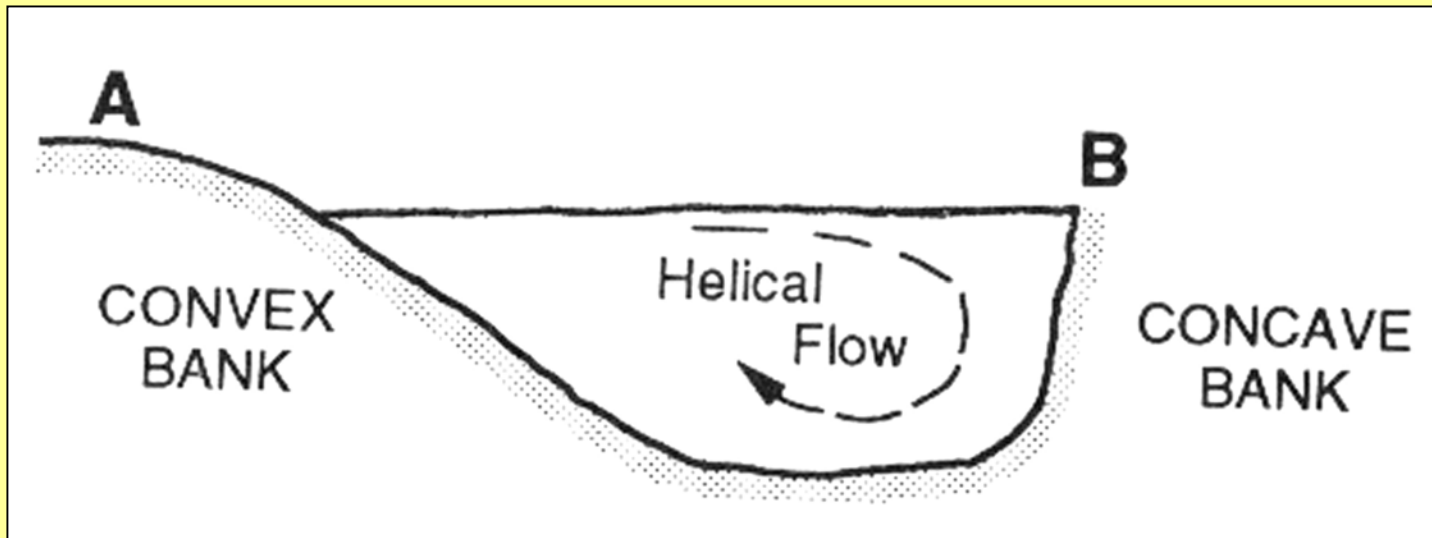




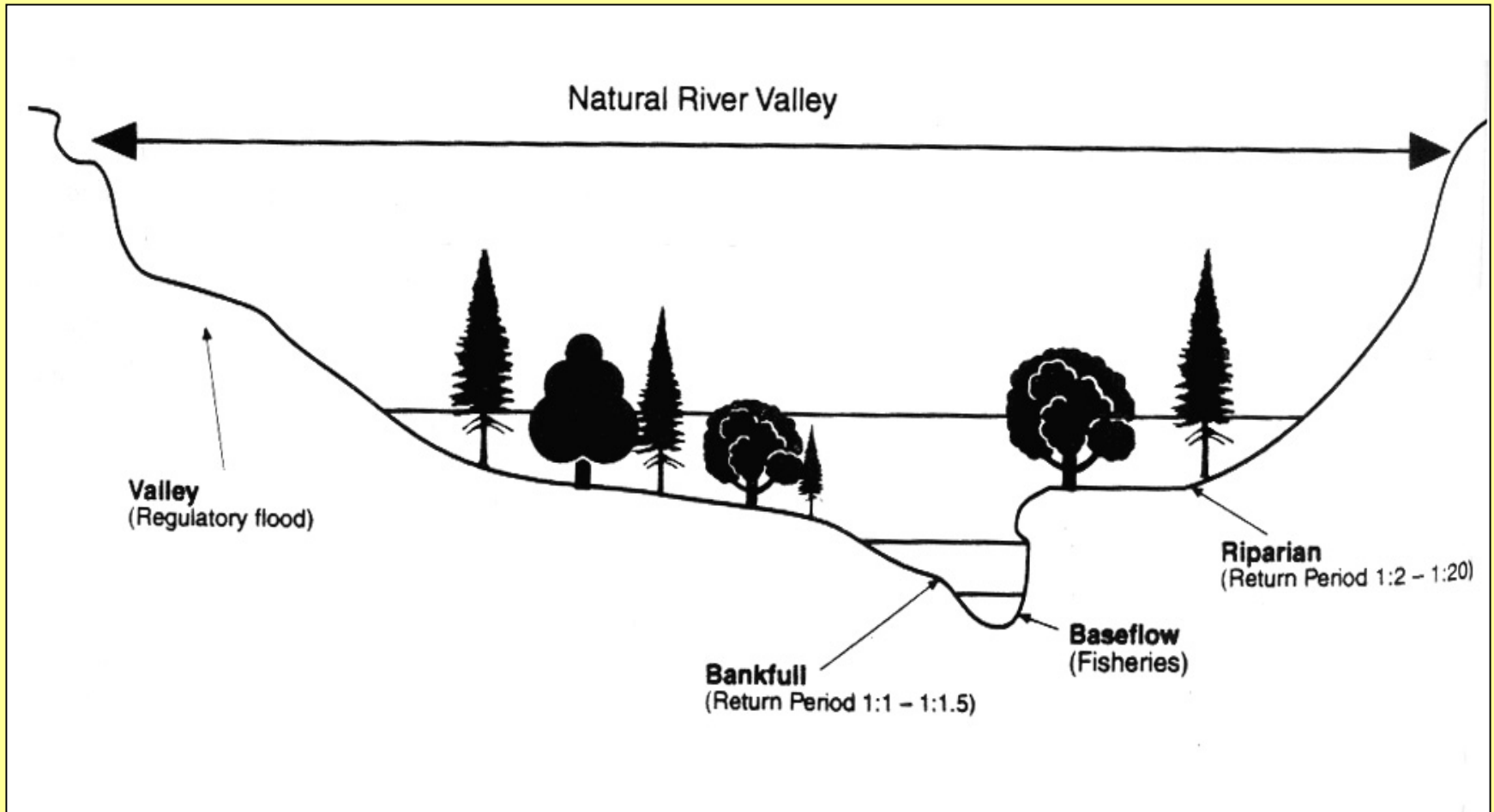
Flow Dynamics



Flow Dynamics



Valley Cross Section



**If You Don't Know Bankfull,
You Don't Know Squat...**



The Concept of Ecological Integrity

Integrity = Physical (including Habitat) +
Chemical Integrity +
Biological Integrity.

Do we measure all of these? Just one?

The physical portion often determines the chemical and biological portions, but we seldom measure the physical portion quantitatively.

FGM gives us physical quantitative measures.

Habitat Heterogeneity



The more habitat variety, the richer the biota.
The Delaware River possesses >50 microhabitats!

Habitat Variety: Fast Water

Riffle

Rapid

Cascade

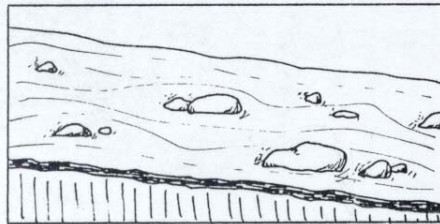
Step Run

Glide

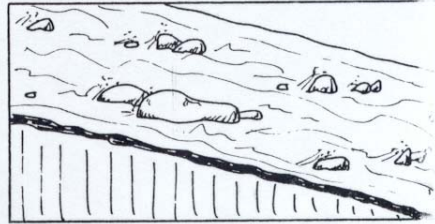
Run

Bedrock Sheet

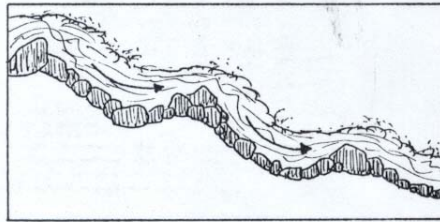
Edgewater



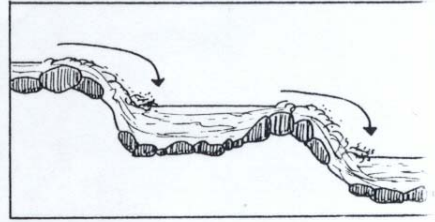
low gradient fast water—riffle



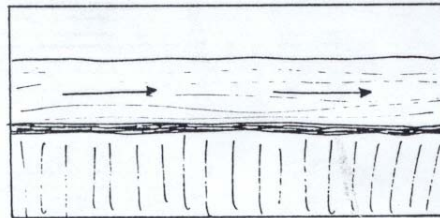
high gradient fast water—rapid



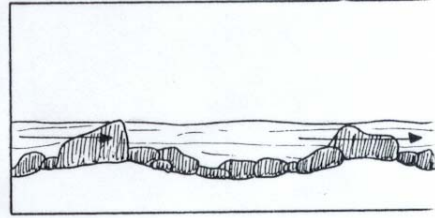
steep gradient fast water—cascade



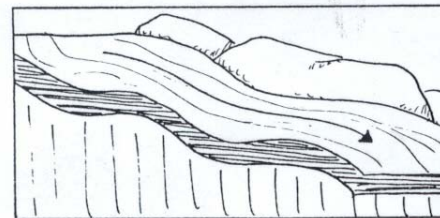
step run



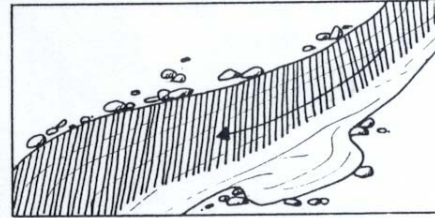
glide



run



bedrock sheet



edgewater

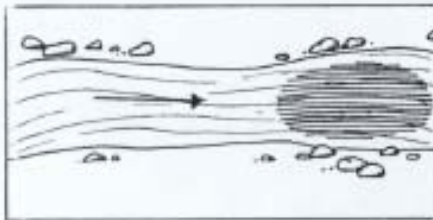
Figure 8.3 Illustrations of fast water habitat classes (from Flosi and Reynolds 1994).

Habitat Variety: Slow Water

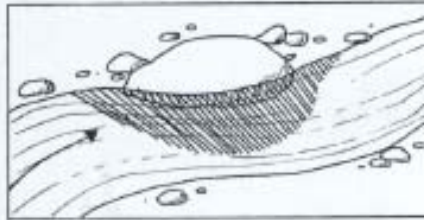
Straight Scour Pools

Lateral Scour Pools

Backwater Pools



straight scour pool



lateral scour pool—boulder formed



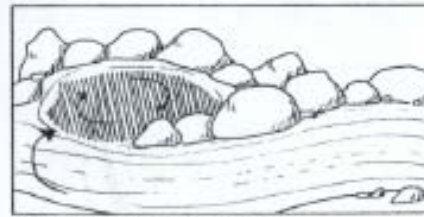
lateral scour pool—bedrock formed



lateral scour pool—log enhanced



lateral scour pool—rootwad enhanced



backwater pool—boulder formed



backwater pool—log formed



backwater pool—rootwad formed

Figure 8.4 Illustrations of slow water habitat classes (from Flossi and Reynolds 1994).

Habitat Variety: Slow Water (Cont'd)

Trench Pools

Confluence Pools

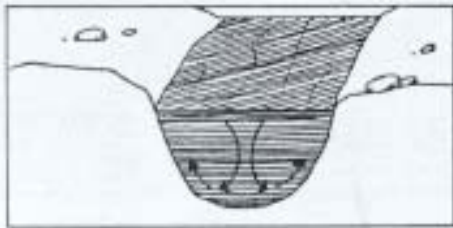
Plunge Pool

Step Pool

Dammed Pond

Secondary Channel

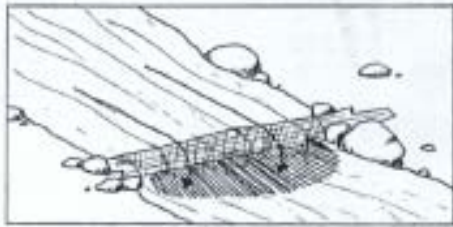
Pocket Water



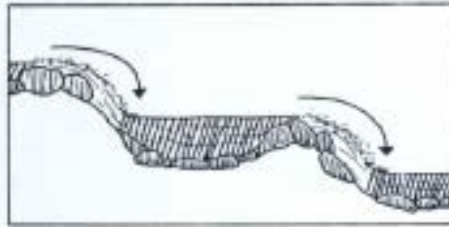
trench pool



channel confluence pool



plunge pool



step pool



dammed pool



secondary channel pool

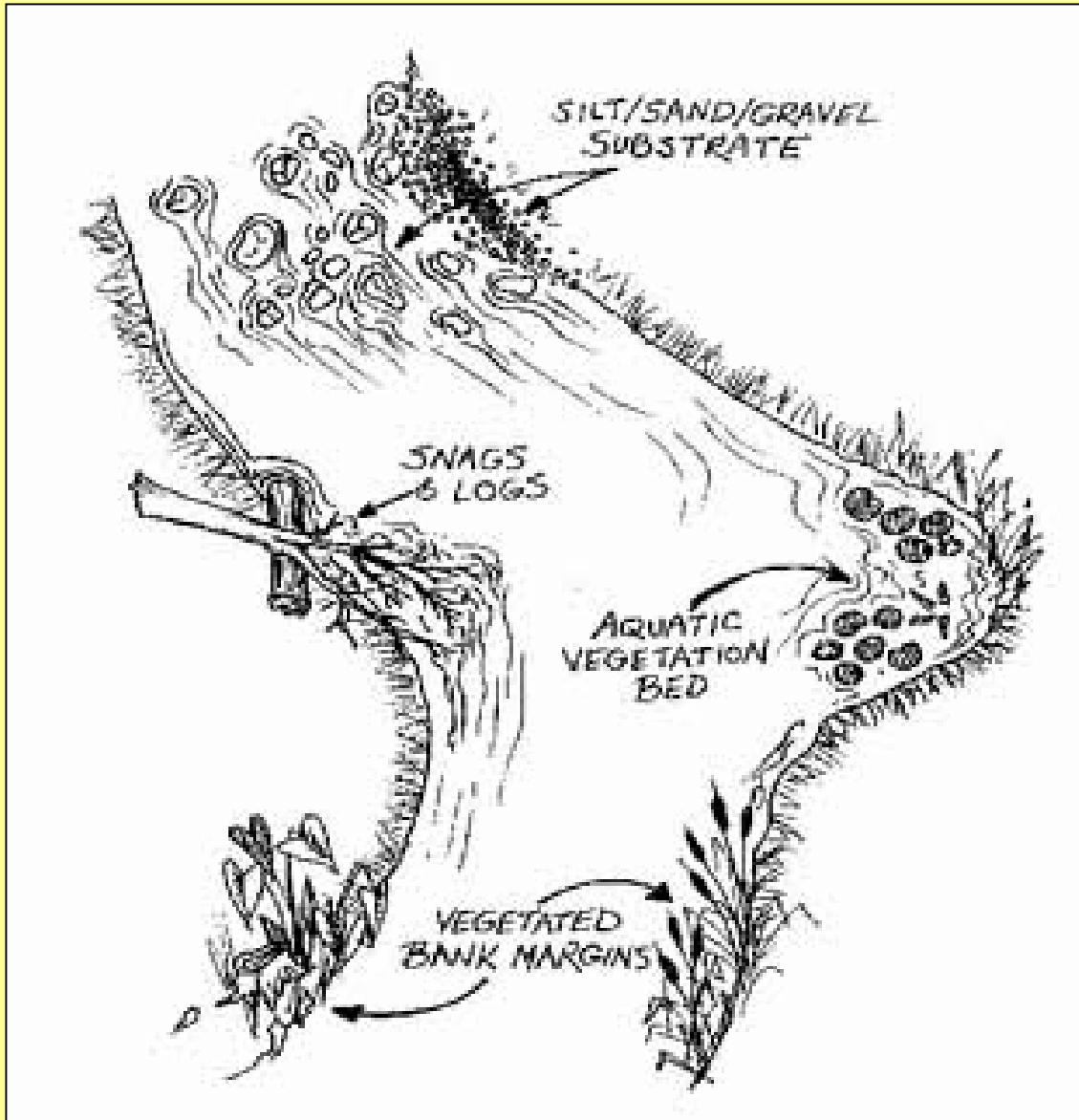


pocket water

Figure 8.4 Illustrations of slow water habitat classes, continued (from Flossi and Reynolds 1994).

Habitat: Low Gradient Streams

4 Basic
Habitat Types



Does Your Study Design Answer Your Questions?

Design to Reduce Errors in Interpretation

Two or more sites, different results... how can you be sure about cause and effect? To confidently interpret your data, you must account for and reduce variability.

Sources of Variability are Many:

Watershed Size; Stream Size; Stream Type; Multiple Stressors; Depth; Velocity; Substrate Size, Light Penetration; Habitat Type; Ecoregion; Your Study Design; Your Sampling Methods; Your Sorting Efficiency; Your Identification Skills; etc.

Avoid Leaping to Conclusions...



Geomorphology Techniques for Volunteers, Part 2: Assessment Tools

Basic Information

Prior to Assessment of Condition

1. Characterize Your Creek

(Maps, Ordination, Aerial Photos, Valley Typing, Gradient, Sinuosity)

2. Pick a Representative Reach

(Know how the stream is supposed to look before deciding what's wrong)

3. Pick a Biological Assemblage to Monitor

(Fish, **Macroinvertebrates**, Aquatic Vegetation, Periphyton, Plankton)

4. Identify Stream Habitat Characteristics

(Gradient; Discharge, Velocity, Depth, Substrate, Sediment; Morphology)

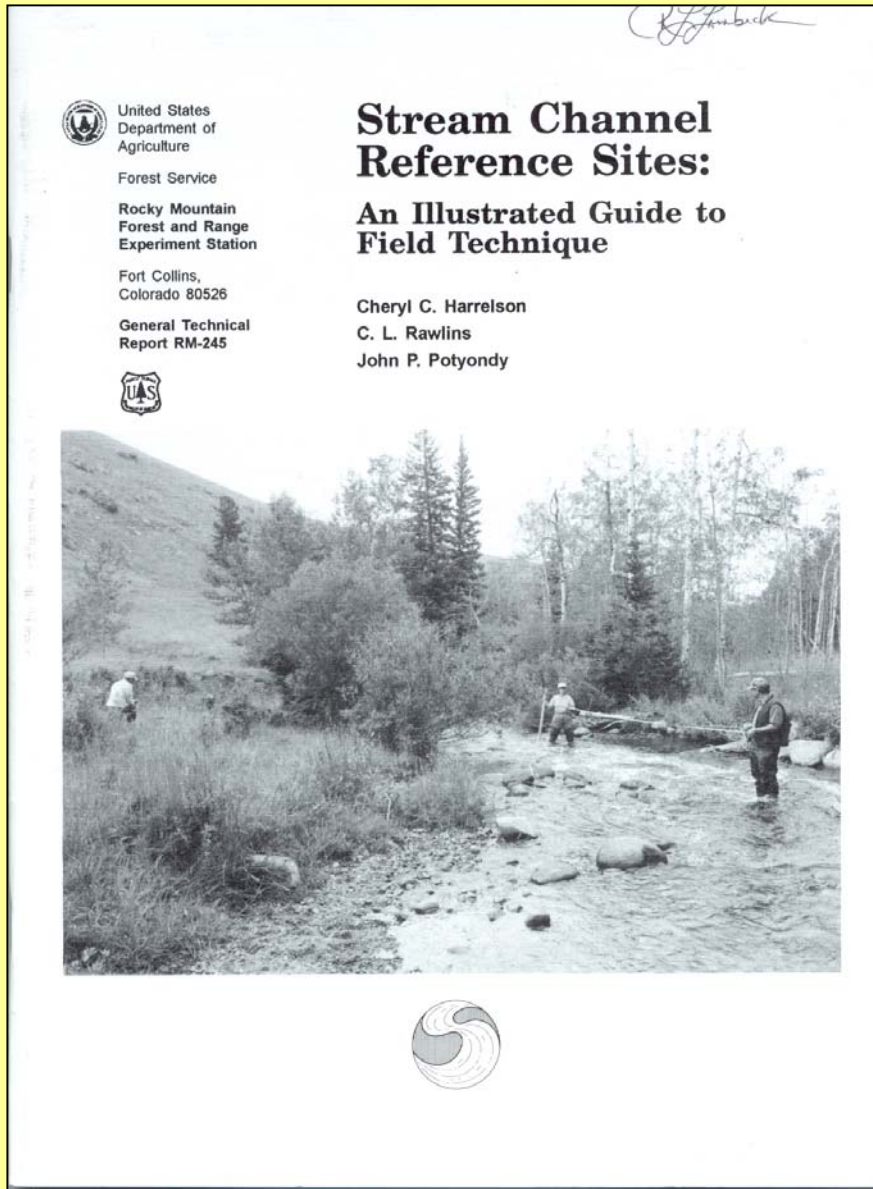
Get This Book

Volunteer Stream Monitoring:

A Methods Manual.

USEPA Office of Water.

EPA 841-B-97-003 (1997)



Get This Book

From USDA
Forest Service

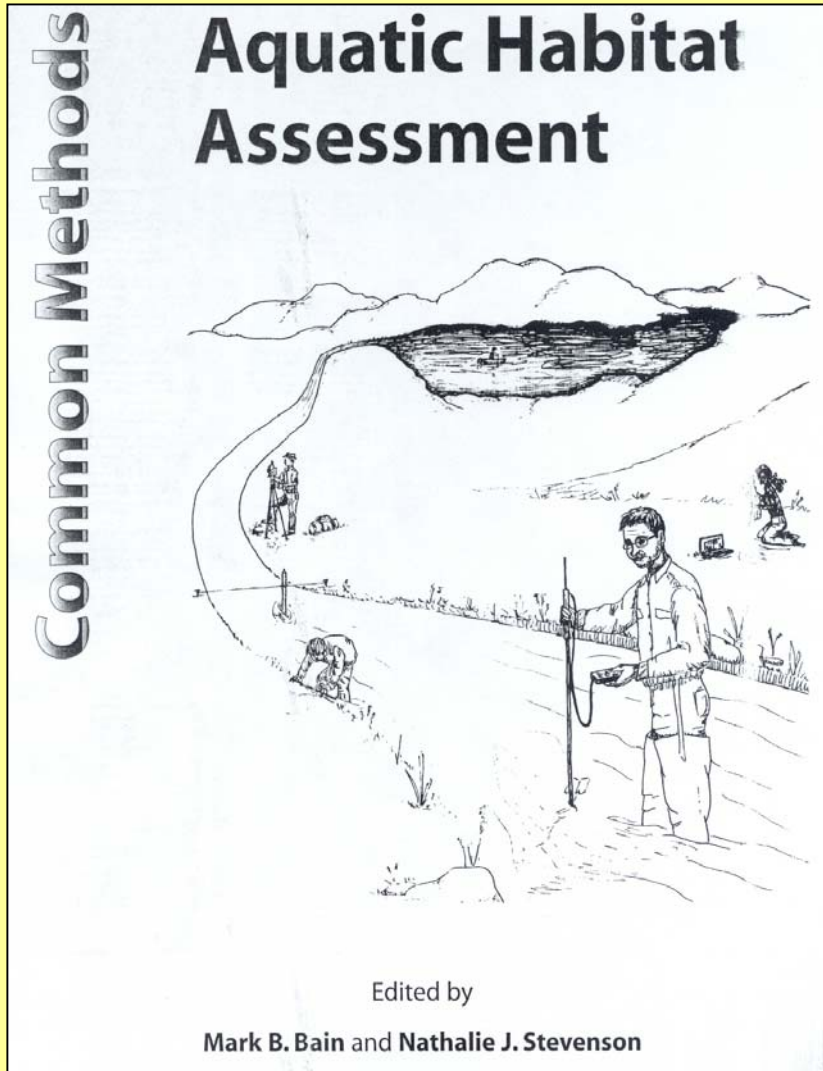
C. Harrelson, C. Rawlins
& J. Potyondy.

Rocky Mountain Forest
and Range Experiment
Station, Ft. Collins, CO.

General Technical Report
No. RM-245 (1994)

www.stream.fs.fed.us/publications/documentsStream.html

Get This Book

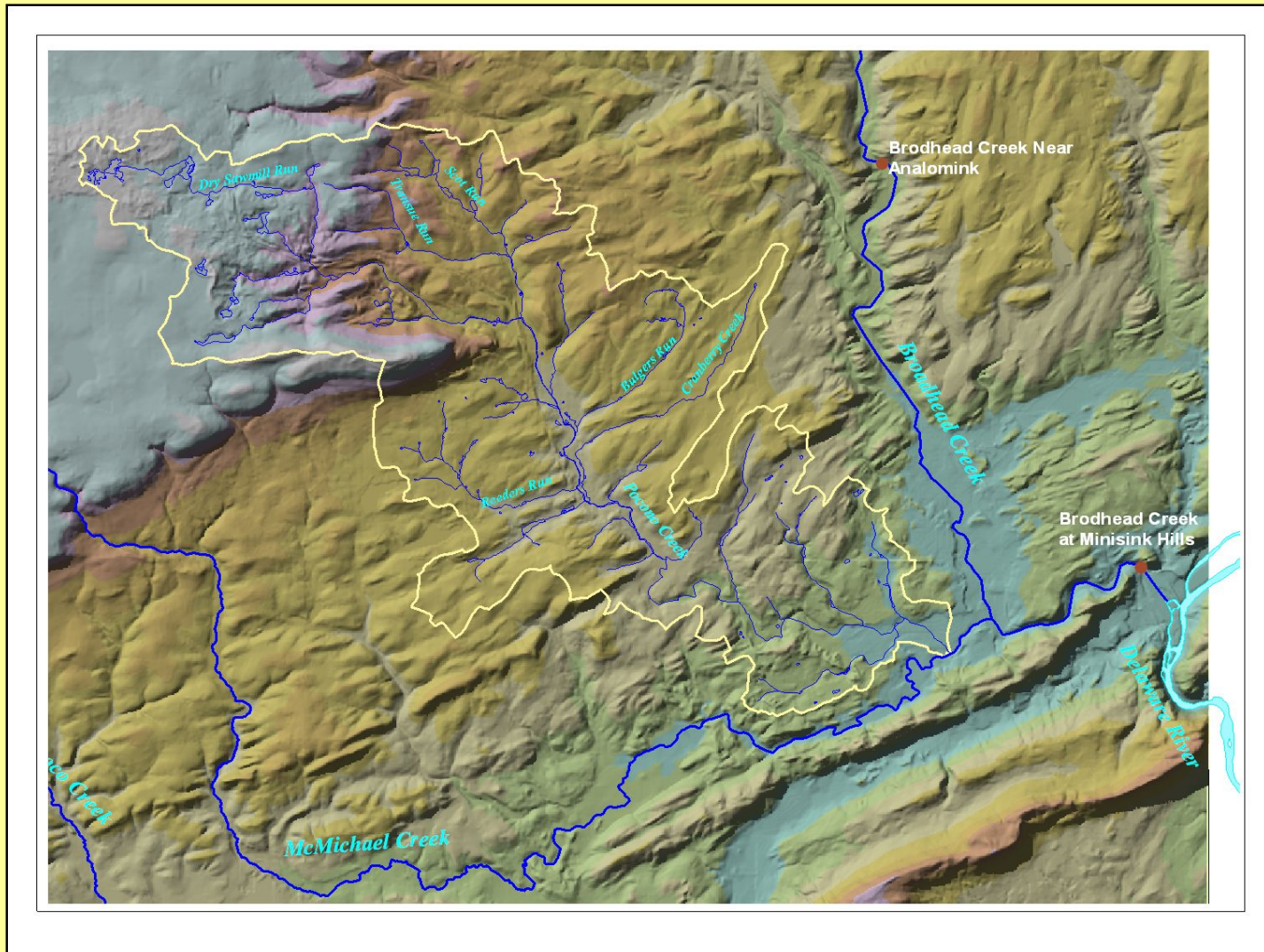


Available From:

American Fisheries Society

www.fisheries.org

Know the Watershed



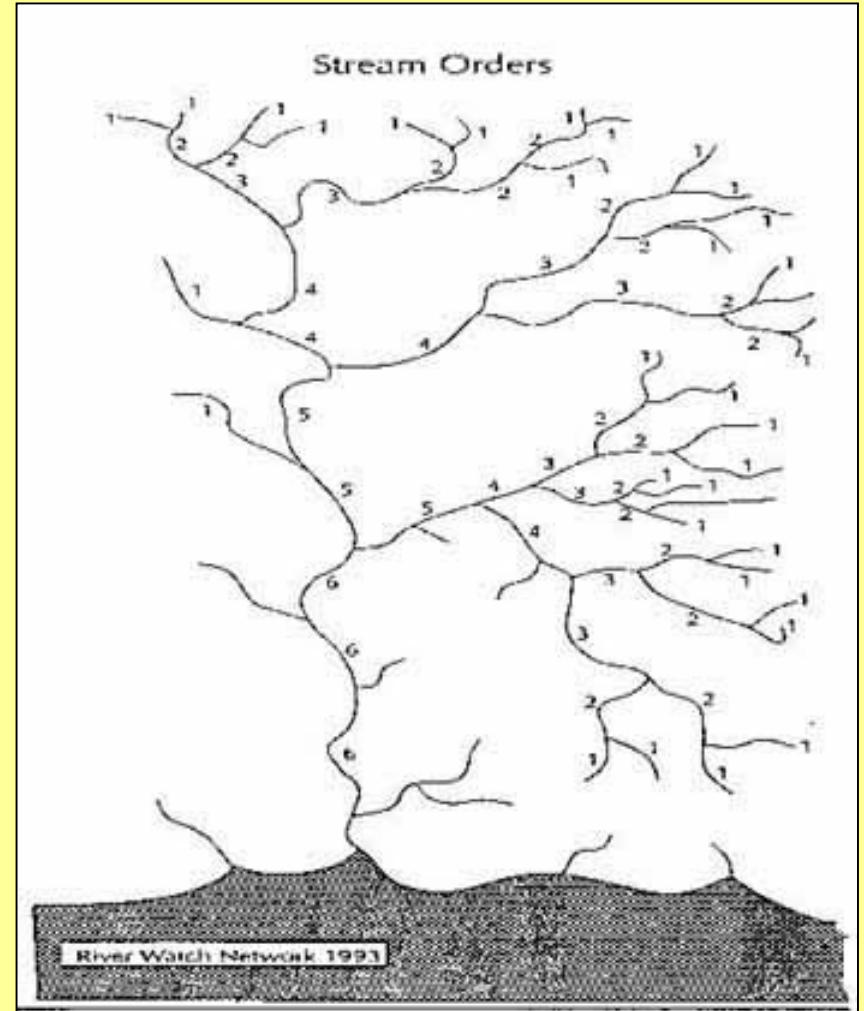
Desk Work: Plot watershed or reach on topographic map and/or aerial photographs

Stream Order

Classify your stream by
Strahler's Stream Ordination
system.

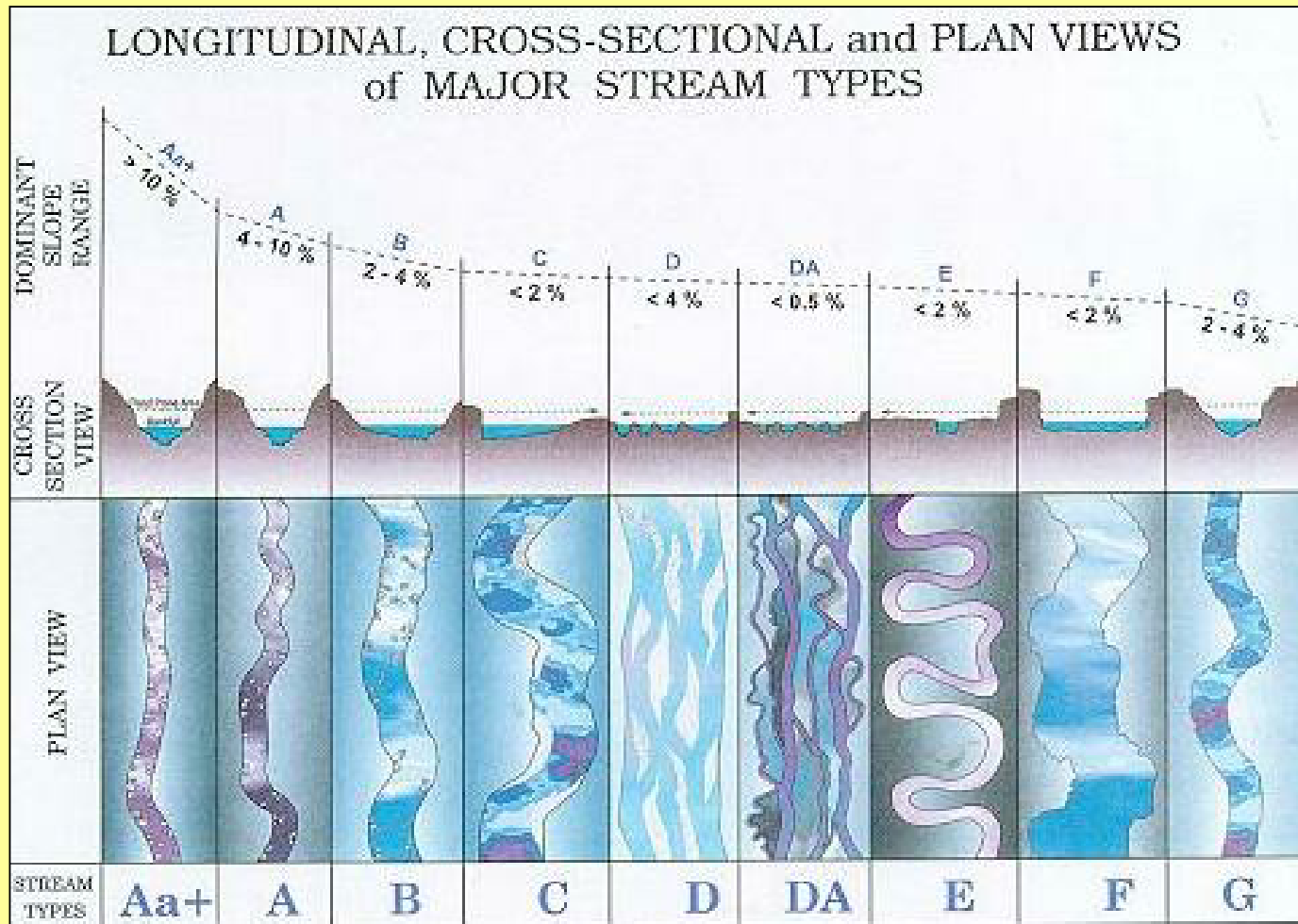
Biological function differs by
stream size.

This may help you predict
biota you expect to see on site.



Source: Volunteer Stream Monitoring: A Methods Manual. USEPA Office of Water. EPA 841-B-97-003 (1997)

Types of Streams



Source: Applied River Morphology, David Rosgen, Wildland Hydrology, Pagosa Springs, CO, 1996.

“A” Channel – Step-Pool, High Gradient



Aa+

B

A

“B” Channel – Continuous Riffle



“C” Channel – Look for Point Bars



“D” Channel – Braided **(Sign of instability in this area)**



Extent of instability below bridge

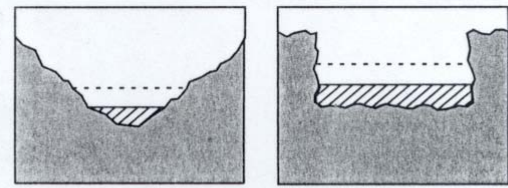
“F” Channel – Wide, Shallow, Entrenched



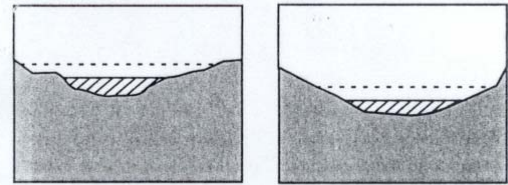
“G” Channel – Incised Gully (BAD!)



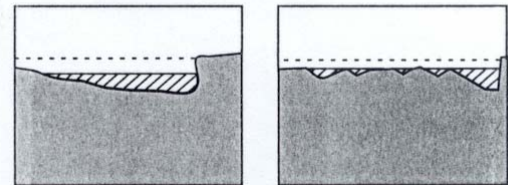
Riparian Condition; Entrenchment & Floodplain Connectivity



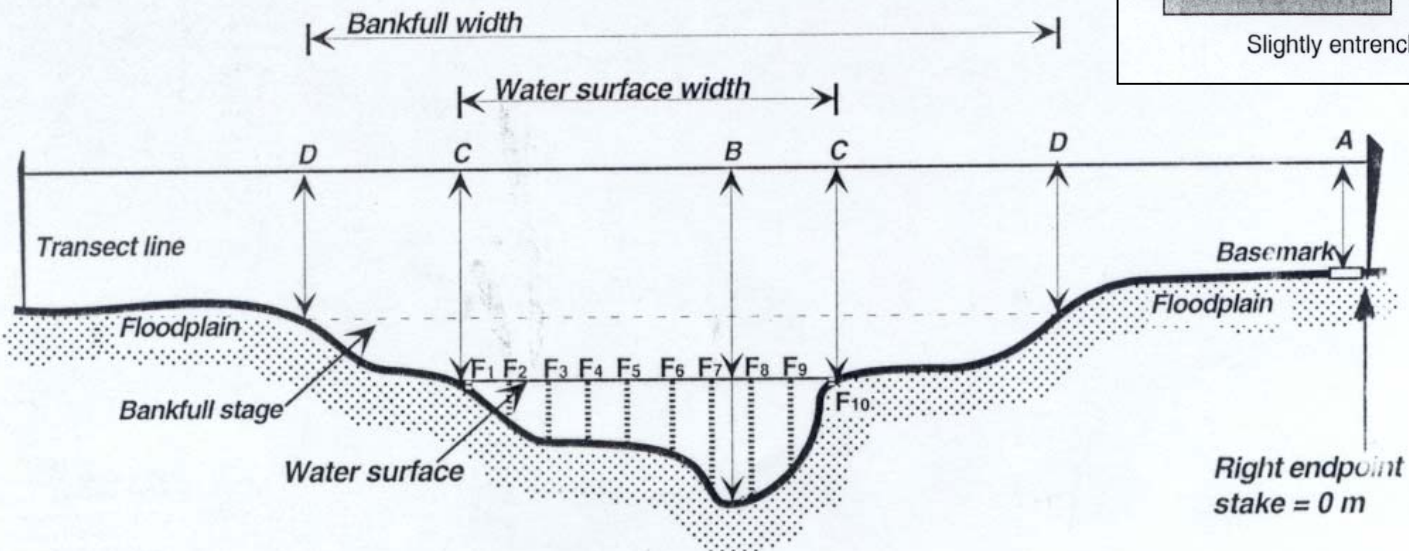
Entrenched (ratio: 1.0–1.4)



Moderately entrenched (ratio: 1.41–2.2)



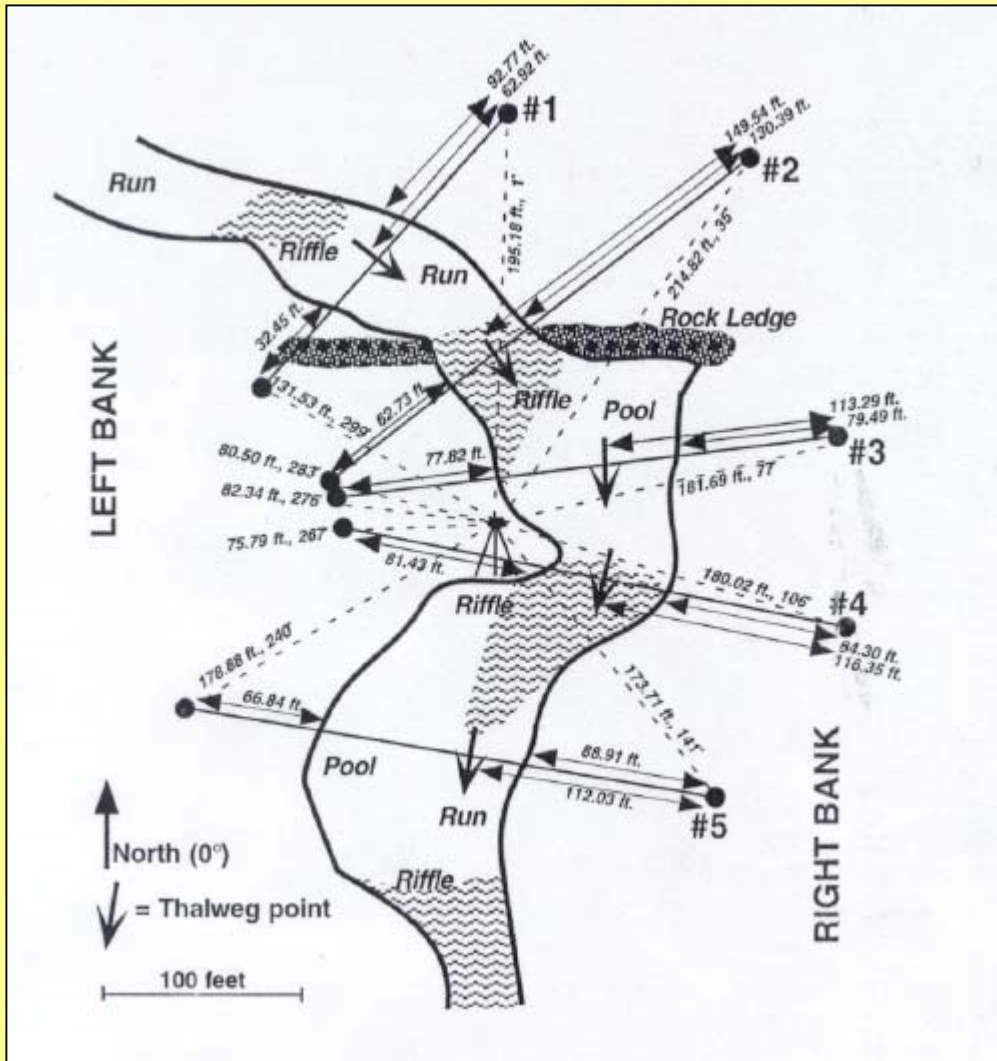
Slightly entrenched (ratio: >2.2)



Measure
Cross
Sections!

A Well- Connected Floodplain

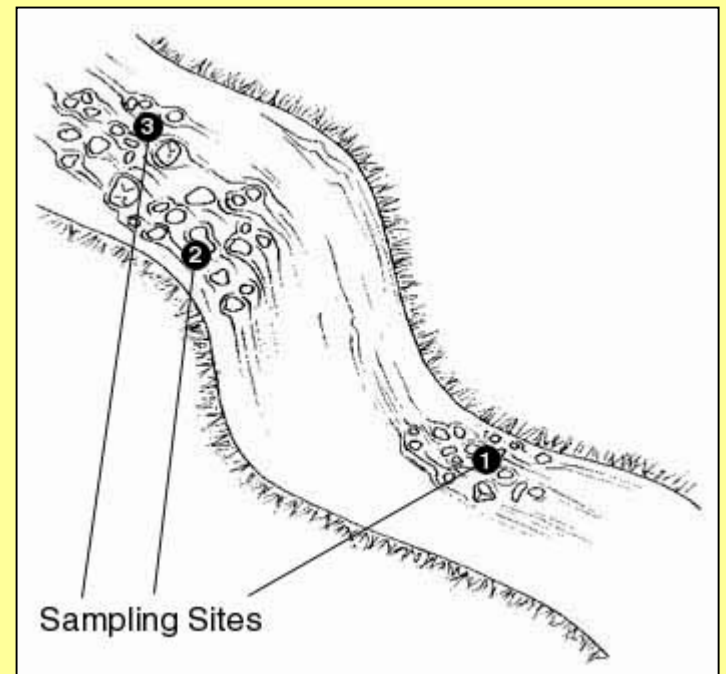




The Sketch Map

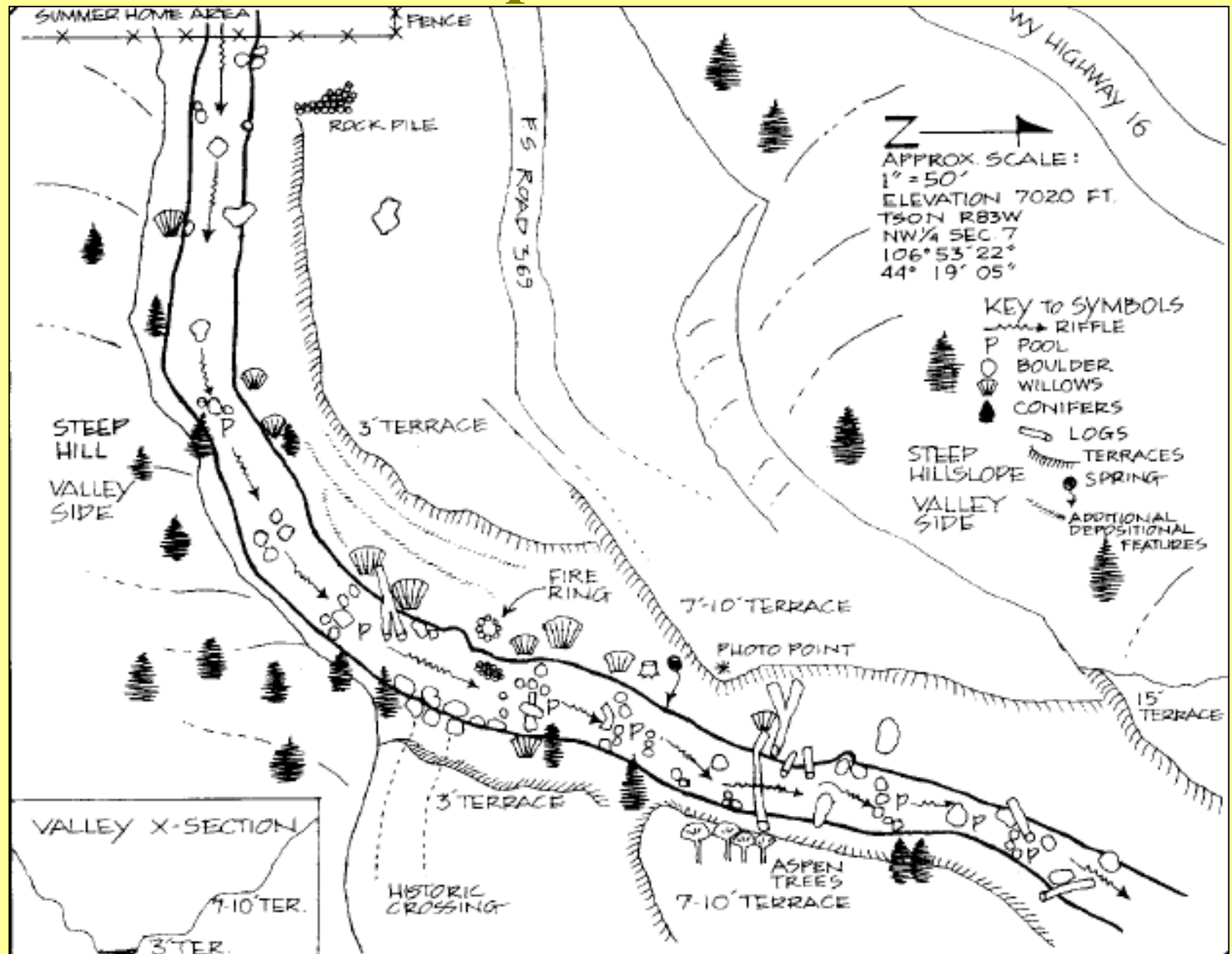
Do all shown here plus:

Photo records
GPS coordinates



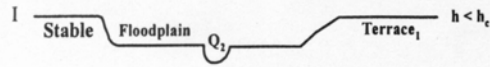
Always Keep a Journal!

The Sketch Map – Cadillac Version

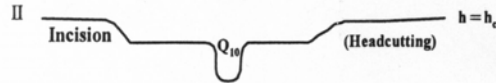


CHANNEL EVOLUTION MODEL (Schumm, Harvey and Watson, 1984)

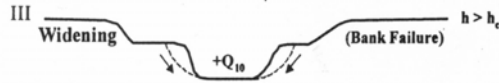
CHANNEL STABILITY INDICATORS



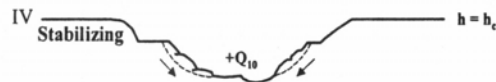
- ☐ well developed baseflow & bankfull channel
 - ☐ consistent floodplain features easily identified
 - ☐ min. of one terrace apparent above active floodplain
 - ☐ predictable pattern & streambed morphology
 - ☐ floodplain covered by diverse vegetation
 - ☐ stable streambank slopes / no apparent slumping
- COMMENTS: _____
- _____
- _____



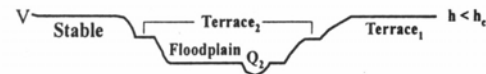
- ☐ headcuts / downcutting
 - ☐ exposed cultural features
 - ☐ sediment deposits absent or sparse
 - ☐ exposed bedrock
 - ☐ streambank slopes vertical at toe
 - ☐ streambank failure imminent
- COMMENTS: _____
- _____
- _____



- ☐ streambank slumping
 - ☐ slumped material eroding
 - ☐ undercut streambank slopes on both sides of channel
 - ☐ erosion on inside of meander bends
 - ☐ accelerated meander bend migration
- COMMENTS: _____
- _____
- _____



- ☐ streambed aggrading
 - ☐ slumped streambank material not eroding
 - ☐ slumped material colonized by vegetation
 - ☐ baseflow, bankfull & floodplain channel developing
 - ☐ predictable sinuous pattern developing
 - ☐ streambank slopes beginning to stabilize / slumping is minimal or absent
- COMMENTS: _____
- _____
- _____



- ☐ well developed baseflow & bankfull channel
 - ☐ consistent floodplain features easily identified
 - ☐ min. of two terraces apparent above active floodplain
 - ☐ predictable pattern & streambed morphology
 - ☐ streambank slopes are stable / no apparent slumping
- COMMENTS: _____
- _____
- _____

h = stream bank height
 h_c = critical bank height
 (bank failure imminent)
 $Q\#$ = frequency of
 runoff event

STREAM REACH ASSESSMENT SUMMARY:

Field Worksheet developed by C.R. Sewell, 1999 (Revised 2002)

Channel Evolution

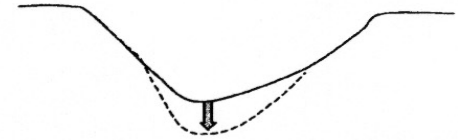
Knowledge of channel evolution state helps you determine restoration strategies and risks.

Incision and Widening produce excess sediment and ruin habitat.

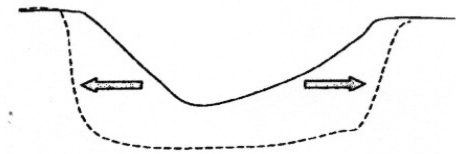
Stages of Channel Incision



Stage 1 - Stable



Stage 2 - Bed Lowering



Stage 3 - Widening



Stage 4 - Deposition



Stage 5 - Restabilization

Figure 2.7 Stages of channel incision

Follow the “Trash Line” to ID Erosion



Basic Equipment

Brain, Time

Backpack or Toolbag

Boots or Waders

Tile Probe

Thorn-Resistant Clothes

Machete

Insect Repellent, Sunscreen

First Aid Kit

Flashlight, Batteries

Cell Phone, Radios

Food and water

Clipboard, Several pencils

Tape measure (300 ft)

Thermometer

Field Data Sheets

Field Notebook

Study Plan (for arguments)

Camera and Film

Maps, Compass

Rangefinder, GPS

A Really Goofy Hat

A Collapsible Chair

Advanced Gear

Surveying Equipment (alternative is hand level & pocket rod)

Biomonitoring: (net, bucket, pan, sorting tray, pickers)

Geomorphology: Gravelometer, Rebar, Sieves

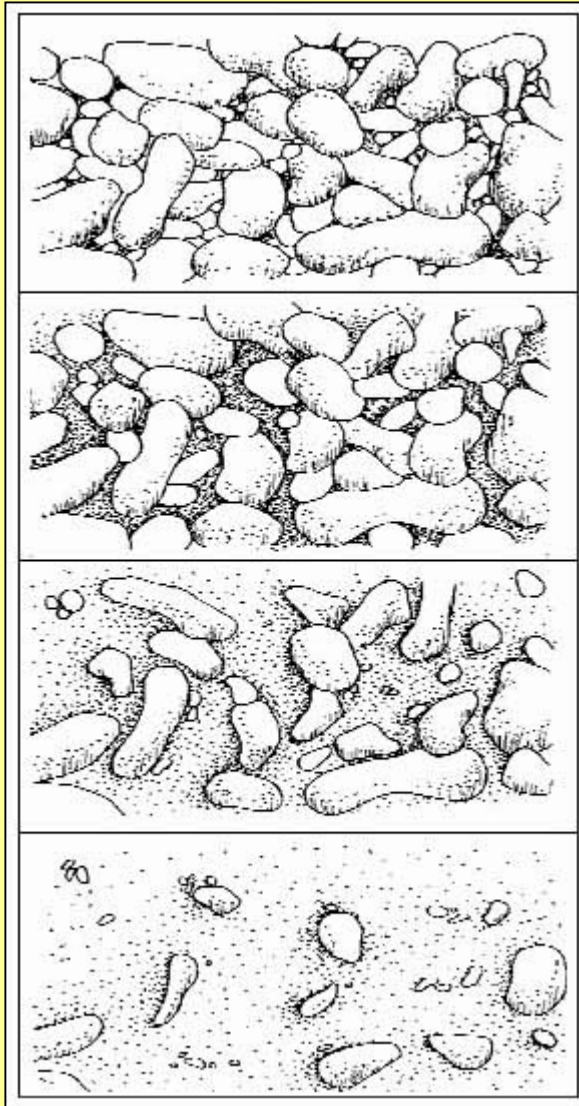
Habitat Equipment: Clinometer, Soils Book

Flow Monitoring: Pygmy Meter; Water Level Logger

Other Stuff to Break: Computer; Handheld Device; Sonde

Forms: Water Quality; Habitat; Pebble Count; Channel Evolution; etc.

Habitat: Embeddedness (Eyeball Method)



Subjective Visual Guide to
Assessment of Stream Bottom

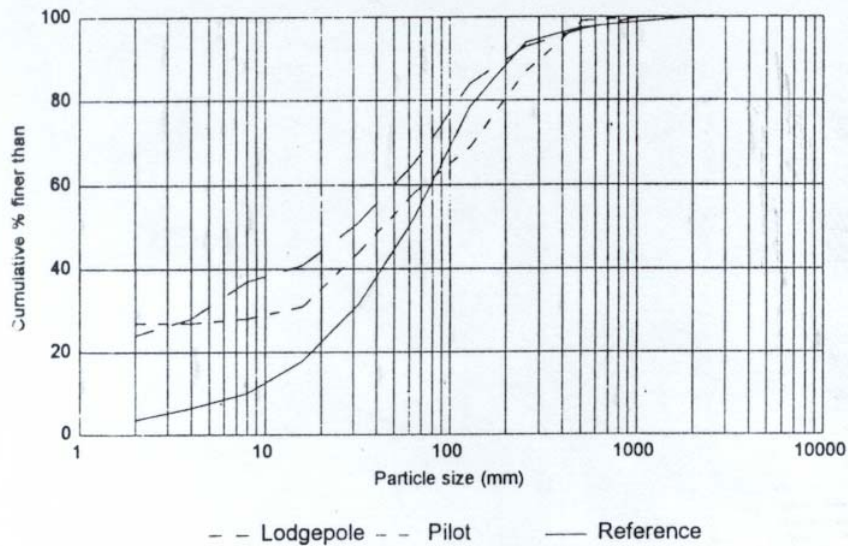
Experienced Eye or Foot Needed

I Prefer to Use a Gravelometer and
Wolman's Pebble Count Method

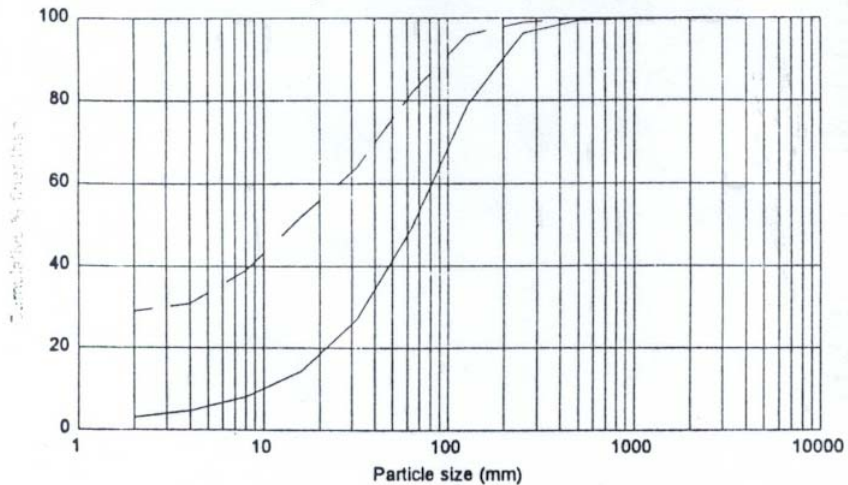
Habitat: Embeddedness (Pebble Count)

Quantitative
Responsive to Stressors

Case Study 1 - Recent Wildfire

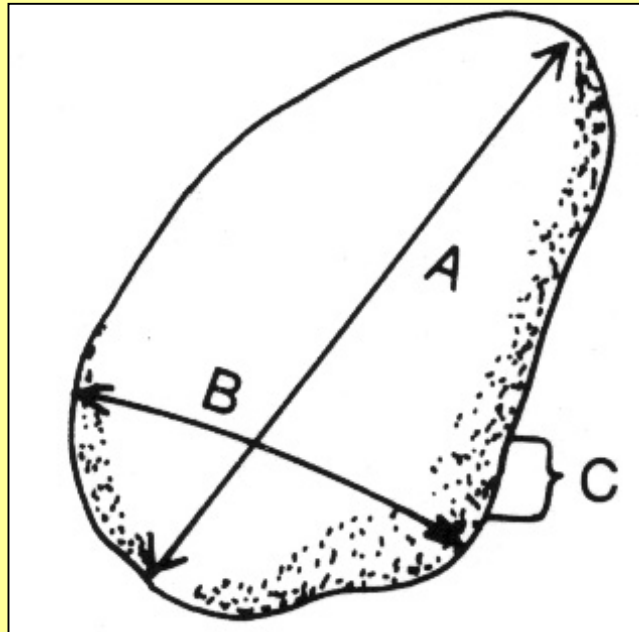


Case Study 3 - Current Stock Grazing



Wolman's Pebble Count

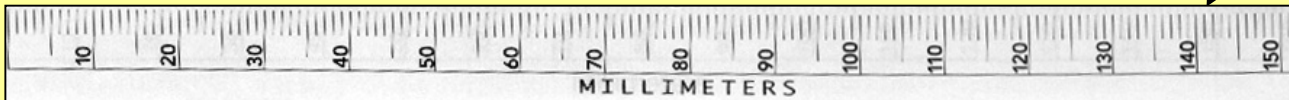
Measure the B axis



Pebble Count

Gravelometer
template by
Albert
Scientific,
West
Trenton.

Millimeter
ruler.

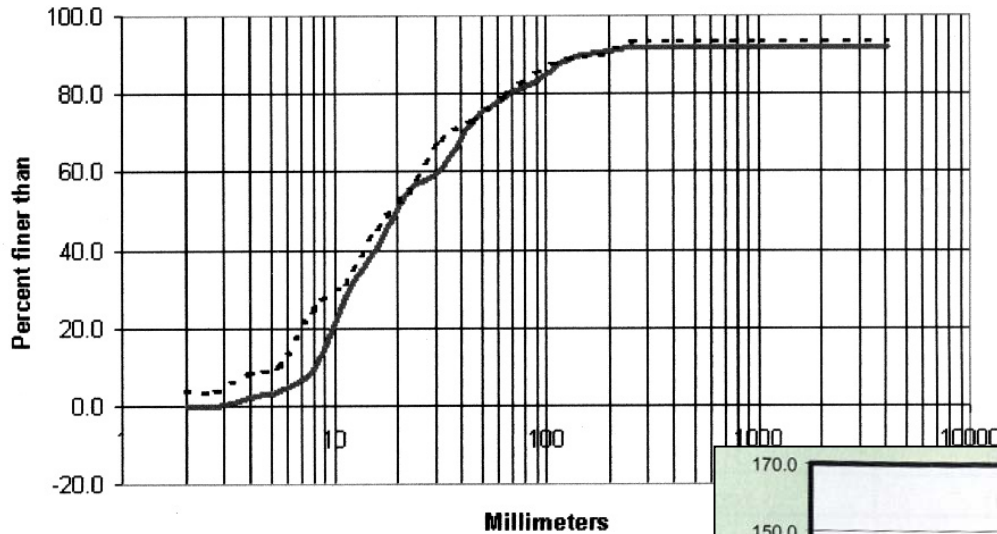


Pebble Count

In a riffle or pool cross section, collect 100 particles across the active channel. Use this form to count and classify by particle size. Particles <2mm are 'fines'. More than 5% fines may reduce habitat.

Party:				Date: 5-1-08
Inches	PARTICLE	Millimeters		PAR
	Silt / Clay	< .062	SILT	....
	Very Fine	.062 - .125	SAND	
	Fine	.125 - .25		
	Medium	.25 - .50		
	Coarse	.50 - 1.0		..
.04 - .08	Very Coarse	1.0 - 2		..
.08 - .16	Very Fine	2 - 4	GRAVEL	.....
.16 - .22	Fine	4 - 5.7		
.22 - .31	Fine	5.7 - 8		....
.31 - .44	Medium	8 - 11.3		.....
.44 - .63	Medium	11.3 - 16		.....
.63 - .89	Coarse	16 - 22.6		.....
.89 - 1.26	Coarse	22.6 - 32		.....
1.26 - 1.77	Very Coarse	32 - 45		.....
1.77 - 2.5	Very Coarse	45 - 64		.....
2.5 - 3.5	Small	64 - 90	COBBLE	.....
3.5 - 5.0	Small	90 - 128		.....
5.0 - 7.1	Large	128 - 180		
7.1 - 10.1	Large	180 - 256		.....
10.1 - 14.3	Small	256 - 362	BO	

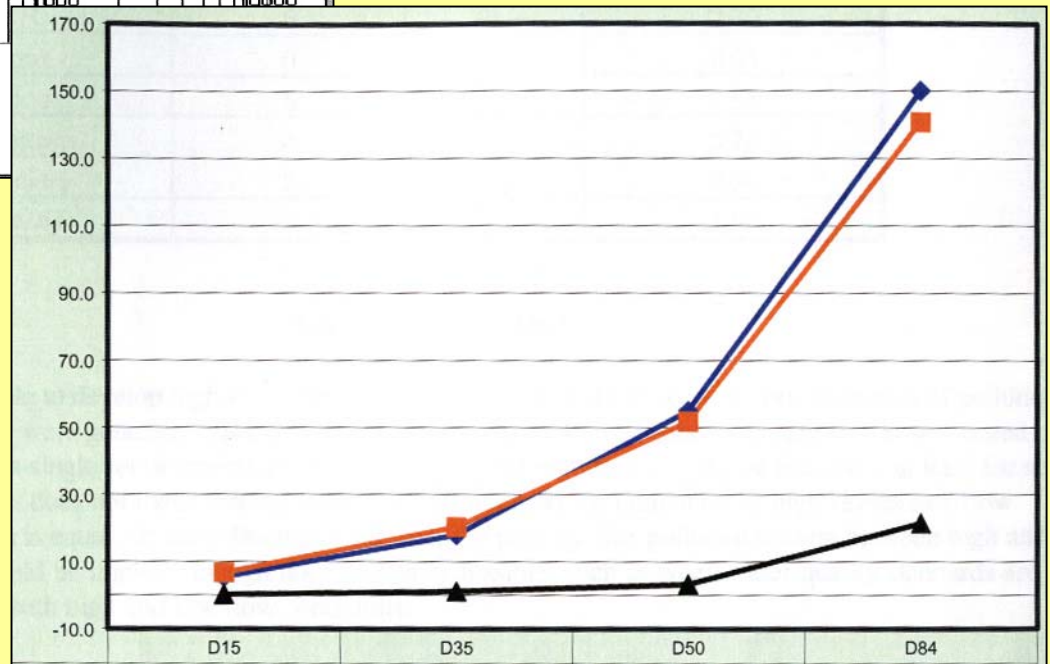
Cumulative Particle Size Distribution



Pebble Count

Before & After
Comparison

Comparison of
Stream Reaches



Ten Uses For A Tile Probe

10. Whacking Multi Flora Rose Etc.

9. Scratching an Itchy Back

8. Leaning on While Toothpick Surveying

7. Scale Reference in Photos

6. Staking Out Survey Tape in Soft Areas

5. Arm extender for climbing banks
4. A third leg for stream walking
3. Surveying aid for cross sections
2. Keeping boot tops above water (depth)
1. Measuring streambank erosion potential

Erosion Potential: A Simple Index

(Scoring)

Hits bedrock = 10 (best)

Stops with thud due to > 12 “ rock = 9

Stops with thud due to 6 to 12” rock = 7

Minimal penetration due to hard
cohesive materials e.g. tight clay = 7

Erosion Potential: A Simple Index

Stops with thud due to 3 to 6" rock = 5

Minimal penetration due to softer
cohesive materials e.g. silt/clay = 5

Sinks with grating sound (gravel) = 3

Tile sinks all the way = 1

- Tip -

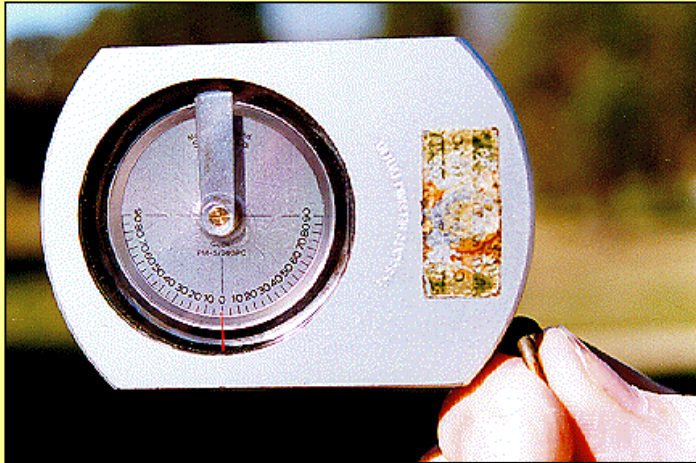
If you reverse the scoring & probe land areas you measure imperviousness

E.G.,

Bedrock = 1 (most impervious)

Tile sinks all the way = 10 (least impervious)

\$100.00



\$11.00

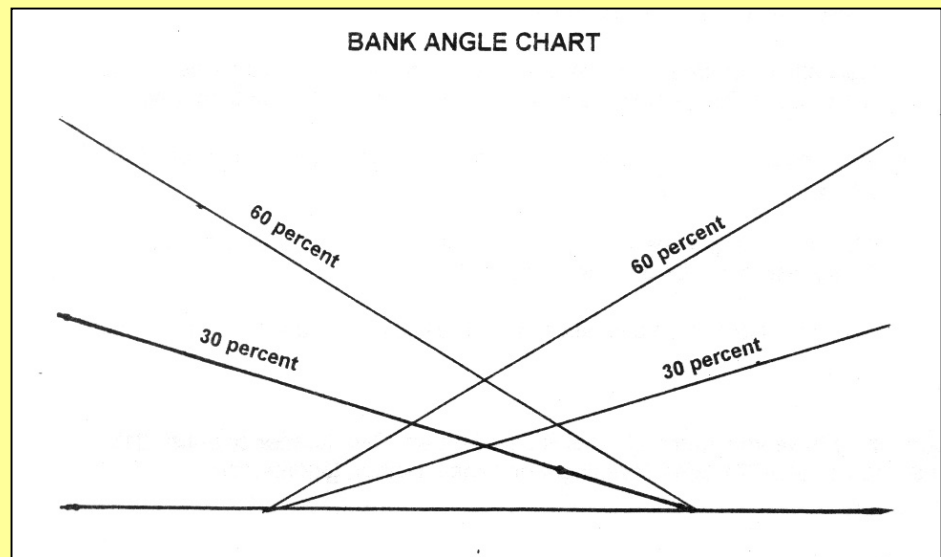


**Bank
Angles
on the
Cheap**

\$2.00



FREE



Comparing Four Rivers

Table 7. Bank Angles

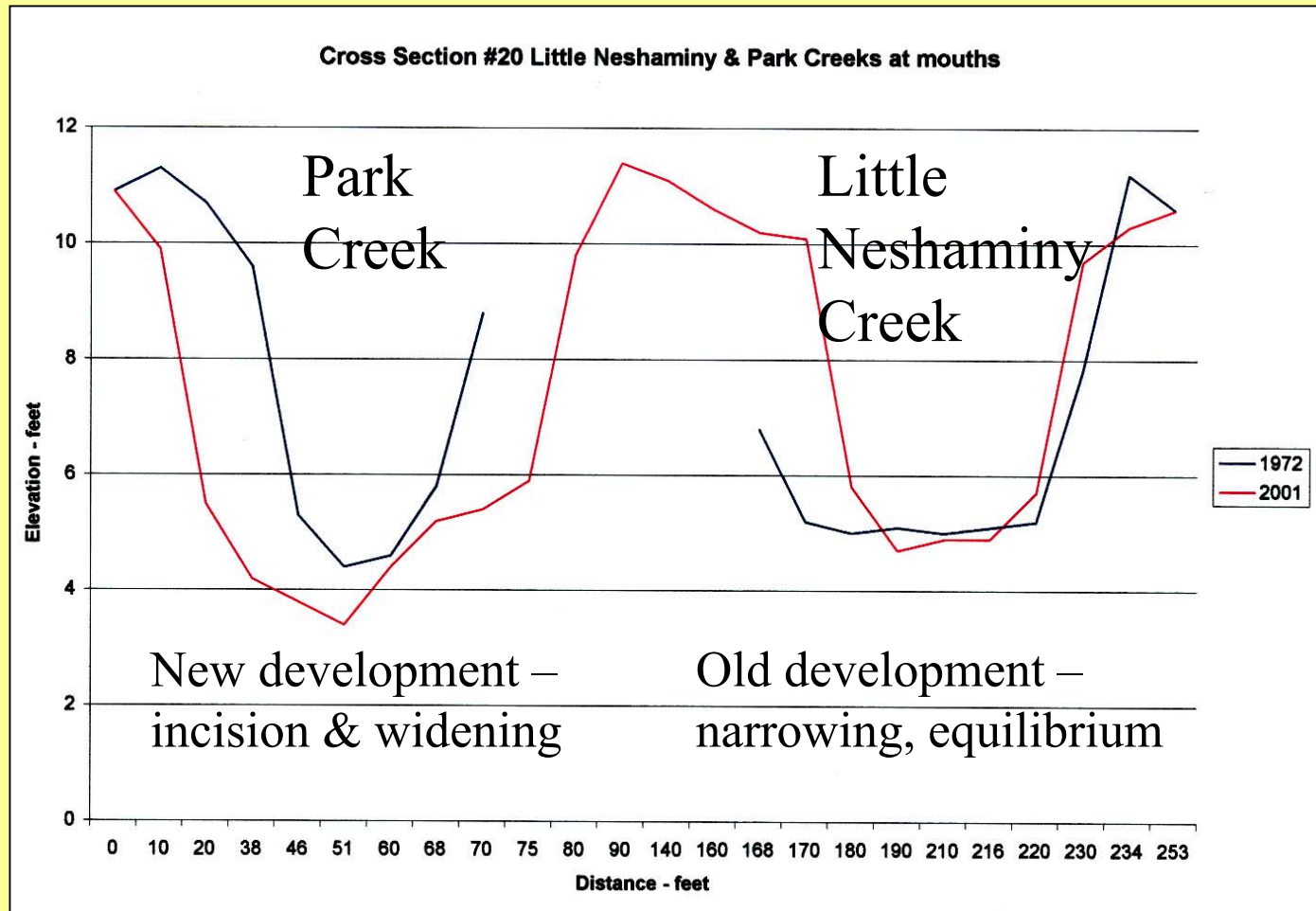
Location	Bank Angle
Whippany	51.2
Saddle River	45.0
Flat Brook	38.0
Lockwood	33.0
Bloomsbury	42.0
Riegelsville	51.2

The higher the mean bank angle (n=30 min along reach), the more undercutting and erosion.

Surveying

DIMENSION, PATTERN
AND
PROFILE

Dimension – Cross Sections



Pattern – Aerial Photos

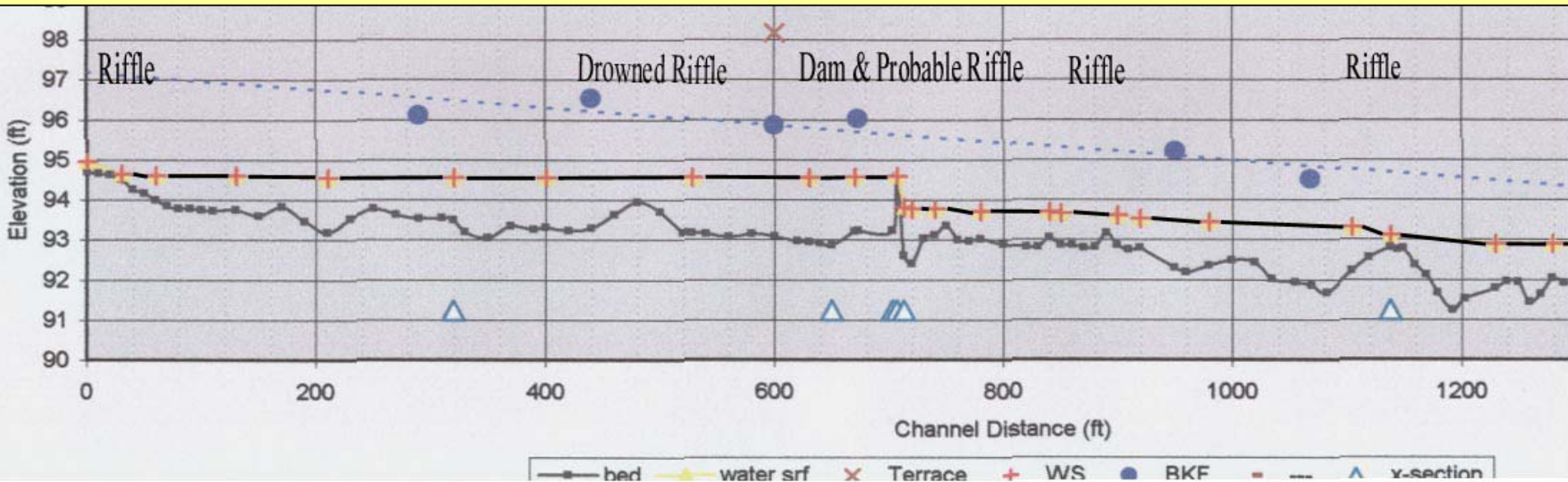


Measure
beltwidth;

Meander
Length;

Sinuosity=
Stream length /
Valley Length

Profile – Longitudinal Surveys



In this example, we calculated how many riffles we could recover by removing a small dam (2 or 3) on Little Neshaminy Creek in Bucks Co.

The Power of Observation



The Power of Observation



Downstream



Upstream



The Power of Observation



The Power of Observation



Questions?

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